

SPECIFICATION

TO ALL WHOM IT MAY CONCERN:

BE IT KNOWN THAT WE, TOSHIO SANO, a citizen of Japan residing at Tokyo, Japan, HIROSHI IEKI, a citizen of Japan residing at Tokyo, Japan, MINORU MIYAJI, a citizen of Japan residing at Tokyo, Japan and HIRONOBU ARIMOTO, a citizen of Japan residing at Tokyo, Japan have invented certain new and useful improvements in

IMAGE SENSOR UNIT

of which the following is a specification:-

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to an image sensor
5 unit, and more particularly, to an improved structure
of a continuously dischargeable light source used in
the image sensor unit, which can improve the starting
characteristic of the light source for achieving
stable glow discharge (that is, so-called continuous
10 electric discharge).

2. Description of the Related Art

In general, photocopy machines, facsimile
machines, scanners, and other image-reproducing
15 machines use an image sensor unit to optically read
the image from the original. Some image sensor units
use a certain type of light source that makes use of
continuous electric discharge occurring between
electrodes, instead of utilizing the light emitting
20 phenomenon of thermal particles from a filament.

One example of the light source making use of the
continuous electric discharge comprises a light-
emitting body made of a dielectric material and
shaped as an airtight container, filled with xenon
25 gas, for example under a prescribed vacuum atmosphere.
In the container, a fluorescent material layer is

provided, except for a certain region, and two electrodes are arranged so as to face each other with a space between them. When a discharge starting voltage is applied between the electrodes, a strong
5 electric field is generated between them, and the gas filled in the container is ionized and excited to produce ultraviolet rays. The ultraviolet rays cause the fluorescent material layer to emit light, functioning as the light source.

10 If the object to be optically scanned, such as an original, has a flat surface, a plate glass with a flat surface is used in the image sensor unit to hold the scanned surface of the original. In this case, the light emitting structure described above is
15 placed below the plate glass so as to irradiate the original from the bottom.

It is important for the above-described type of image sensor unit to reliably provide the starting characteristic of the light source. Accordingly, it
20 is proposed to create a localized area of the strong electric field effect to enhance the electric discharge efficiency, thereby securing continuous light emission across the entire range (see, for example, JPA 11-283579). It is also proposed to use
25 an additional light source to irradiate the light

emitting body in order to ionize and excite the gas filled in the light emitting body (see, for example, JPA 4-106896). Still another proposal is to mix a material that easily emits electrons in the

5 fluorescent material used in the light emitting body, instead of irradiating the light emitting body (see, for example, JPA 2000-156203 and JPA 2001-123988). Yet another proposal is that a portion of the fluorescent layer be removed so as to allow initial

10 electrons to emit from this removed portion for the purpose of starting ionization and excitation of the gas (see, for example, JPA 2001-102004). The emission of the initial electrons is compared to a "small flame" for sequentially causing ionization and

15 excitation to achieve continuous electric discharge.

However, there are several problems in the above-described prior art techniques of enhancing the starting characteristic.

First, the conventional method of generating a

20 strong electric field requires auxiliary electrodes to generate such a strong electric field, and the configuration of the light emitting body, including the ordinary electrodes, has to be changed. This results in increased cost. Particularly, if the

25 height of the discharge space defined by the light

emitting body is insufficient, the insulating distance of the auxiliary electrodes cannot be maintained reliably. This drawback may cause dielectric breakdown, and therefore, cause the light source to return to the dark state, causing dark current. In addition, the lighting circuit may be damaged, or the inside of the image sensor unit may be burned. Consequently, the starting characteristic cannot be improved efficiently.

10 Second, with the prior art technique using an additional light source, or mixing a material that easily emits electrons in the fluorescent layer, the emitted electrons are likely to be captured if the purity of the gas filled in the light emitting body is degraded. Since this phenomenon adversely affects the efficiency of the ionization and the excitation of the gas, the purity of the gas has to be maintained high. In addition, when a portion of the electrode is exposed, sputtering occurs on the exposed surface of the electrode, and the illumination of the light source decreases.

20 Third, with the prior art technique of removing a portion of the fluorescent material layer to expose the underlying layer or material to the gas, the quantity of light may become uneven or insufficient

within the scanning range of the original, which is the scanning target of the image sensor unit. This may cause the S/N ratio to be degraded. In addition, since most of the surface of the light emitting body
5 made of a dielectric is covered with the fluorescent material layer, the voltage applied between the electrodes has to be increased in order to guarantee initial emission of electrons. It is difficult for the light source of this technique to maintain
10 electric discharge continuously along the longitudinal axis of the light emitting body, even if weak electric discharge has occurred at the exposed portion, and in the worst case, electric discharge may stop.

15 Therefore, it is an object of the present invention to overcome the above-described problems in the conventional image sensor units, especially in the light emitting part making use of continuous electric discharge, and to provide an image sensor
20 unit with an improved starting characteristic that can prevent undesirable dielectric breakdown and cost increase. This image sensor unit has a light emitting body that is capable of providing continuous electric discharge across the entire scanning area of the
25 light emitting body, while preventing the degradation

of the S/N ratio.

SUMMARY OF THE INVENTION

5 To achieve the object, an image sensor unit
having an electric discharge light emitting lamp for
producing an illumination beam is provided. The lamp
comprises a first electrode and a second electrode
facing each other and defining a discharge space
10 between them along the longitudinal axis of the lamp.
A first light emitting layer and a second light
emitting layer are provided in the discharge space so
as to face each other and to cover the first and
second electrodes, respectively. A dielectric
15 material is inserted between the first electrode and
the first light emitting layer, and between the
second electrode and the second light emitting layer.
At least one of the first and second light emitting
layers is arranged so as to define an uncovered
20 region, in which at least one of the dielectric
material, the first electrode, and the second
electrode is exposed to the discharge space.

When a voltage is applied between the first and
second electrodes, initial electrons emit from the
25 uncovered region, which causes electric discharge in

the discharge space in which electrically charged particles collide each other. Ultraviolet rays generated from the electric discharge illuminates the light emitting layer that faces the discharge space, causing the light emitting layer to emit an illumination beam.

The uncovered region, which is not covered with the light emitting layer, extends from one end of the lamp continuously or discontinuously along the longitudinal axis of the lamp.

It is desirable for the uncovered region to be arranged outside the scanning area of the image sensor unit.

Preferably, in the uncovered region, a photoemission material that easily emits photoelectrons is contained.

If the dielectric material is exposed to the discharge space in the uncovered region, a photoemission material is contained in the exposed portion of the dielectric material.

Alternatively, if the first or second electrode is exposed to the discharge space in the uncovered region, a photoemission material is contained in the exposed portion of the first or second electrode.

Preferably, the image sensor unit further

comprises an external light source configured to irradiate the uncovered region of the lamp.

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BRIEF DESCRIPTION OF THE DRAWINGS

Other objects, features, and advantages of the present invention will become more apparent from the following detailed description when read in
10 conjunction with the accompanying drawings, in which:

FIG. 1 is a schematic perspective view of the image sensor unit according to an embodiment of the present invention;

15 FIG. 2 is a schematic diagram of the image sensor used to explain the scanning operation of the image sensor unit shown in FIG. 1;

FIG. 3 is a vertical cross-sectional view of the light emitting lamp used in the image sensor unit
20 shown in FIG. 1, taken along the longitudinal axis of the light emitting lamp;

FIG. 4 is a perspective view of the light emitting lamp shown in FIG. 3;

FIG. 5 is a plan view of the first part of the
25 light emitting lamp of FIG. 3 viewed in the direction

indicated by the arrows (5) in FIG. 3, illustrating the arrangement of the uncovered regions;

FIG. 6 illustrates the positional relation between the light emitting layer and the insulating layer positioned below the light emitting layer, which is used to explain the arrangement of the uncovered regions shown in FIG. 5;

FIG. 7 illustrates the positional relation between the light emitting layer and the internal electrode, which is used to explain the arrangement of the uncovered regions shown in FIG. 5;

FIG. 8 is plan view of the second part of the light emitting lamp of FIG. 3 viewed in the direction indicated by the arrows (8), illustrating the arrangement of the uncovered regions; and

FIG. 9 illustrates the positional relation between the light emitting layer and the external electrode, which is used to explain the arrangement of the uncovered regions shown in FIG. 8.

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DETAILED DESCRIPTION OF THE EMBODIMENTS

The preferred embodiments of the present invention will now be described in detail with reference to the attached drawings.

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FIG. 1 is a schematic perspective view of the image sensor unit according to an embodiment of the present invention. The image sensor unit 1 comprises a casing unit 1A, in which a light emitting lamp 2, a
5 SELFOC lens array 3 that defines a focusing light transmission body, and a circuit element substrate 4 on which a set of light-receiving elements are accommodated.

In the scanning operation of the image sensor
10 unit 1, the original O placed on the mount, such as the contact glass 5, is irradiated by the illumination light emitted from the electric discharge light emitting source (or the lamp) 2, as indicated by the arrow of the dashed line in FIG. 2.
15 The light reflected from the original O is focused onto the light-receiving element 4A formed on the circuit element substrate 4, via the SELFOC lens array 3, thereby reading the images or information from the original O. The numerical reference 6
20 denotes the connector for electrically connecting the circuit element substrate 4 to an external controller (not shown).

FIG. 3 and the subsequent figures illustrate the structure of the light emitting lamp 2.

25 FIG. 3 is a vertical cross-sectional view of the

light emitting lamp 2 taken along the longitudinal axis thereof. The light emitting lamp 2 comprises a first plate 2A and a second plate 2B, each being transparent to light and made of a dielectric
5 containing a photoemission material, such as an oxide of an alkaline-earth metal. The first and second transparent plates 2A and 2B are combined together and sealed with a sealing member 2C (e.g., frit glass) in an airtight manner to form a lamp body. In
10 the lamp body, a discharge space 2D is formed between electrodes 22 and 23. The discharge space 2D is set to the prescribed vacuum atmosphere, and filled with a discharge gas, such as xenon (Xe) gas.

The internal electrode 22 is provided on the
15 first plate 2A so as to face the discharge space 2D. The internal electrode 22 is covered with an insulating layer 21 for electrical insulation, on which a light-emitting layer 20 made of a fluorescent material is placed. The inner face of the second
20 plate 2B is furnished with a light emitting layer 20' made of a fluorescent material, facing the discharge space 2D. The external electrode 23 is provided on the outer face of the second plate 2B. The external electrode 23 is positioned so as to face the internal
25 electrode 22 formed on the first plate 2A via the

second plate 2B and the discharge space 2D.

Harnesses 24 and 24' are soldered to the internal electrode 22 and the external electrode 23, respectively. The harnesses 24 and 24' are connected
5 to the external lighting circuit (not shown) at the other ends. Although not shown, the external electrode 23 may be furnished with a grounding structure, or alternatively, covered with an insulating film, for the purpose of safe operation
10 and shielding external noise.

The light emitting lamp 2 of this example is designed so as to emit light from a plane perpendicular to the top face of the second plate 2B on which the external electrode 23 is provided, as
15 indicated by the dashed arrow R in FIG. 4.

Certain regions of the inner faces of the first and second plates 2A and 2B are not covered with the light emitting layers 20 and 20', as indicated by symbols D and D', respectively, along the
20 longitudinal axis of the light emitting lamp 2. These regions are referred to as the uncovered regions D and D'. Portions of the electrodes 22 and 23, which define the charged particle colliding space of the discharge gas, fall in the uncovered regions D and D'.
25 With this arrangement, the insulating layer 21,

and/or the electrode 22, and/or the electrode 23 are exposed to the discharge space 2D, without being covered with the light emitting layer 20 or 20'.

The uncovered regions D and D' are located at or
5 near the end of the light emitting lamp 2. The uncovered regions D and D' may extend from the end of the light emitting lamp 2 continuously along the longitudinal axis of the light emitting lamp 2, or alternatively, they may be located locally or
10 discontinuously in the light emitting lamp 2. In either case, if a large-sized uncovered region is produced, such a large region is arranged outside the scanning area in order to prevent the light quantity from decreasing locally or from becoming uneven in
15 the scanning range. This arrangement can also prevent the S/N ratio from degrading during the operation of optically reading an original.

FIG. 5 illustrates a plan view of the first plate 2A viewed from the arrow (5) shown in FIG. 3. In this
20 example, the uncovered region D1 is located at one end of the light emitting layer 20, and another uncovered region D2 extends from the region D1 along the lengthwise edge of the light emitting layer 20 parallel to the longitudinal axis thereof. A portion
25 of the insulating layer 21 and/or a portion of the

internal electrode 22 falls in the uncovered regions D1 and/or D2, which will be explained below.

FIG. 6 is a plan view of the first plate 2A, illustrating the positional relation between the
5 light emitting layer 20 and the insulating layer 21 formed on the first plate 2A. A portion of the insulating layer 21 is exposed to the discharge space 2D because the light emitting layer 20 does not cover the insulating layer 21 in the uncovered regions D1
10 and D2. In this example, the underlying internal electrode 23 (not shown in FIG. 6) is formed so as to project from the light emitting layer 20, but not to project from the insulating layer 21.

A photoemission material, such as an oxide of an
15 alkaline-earth metal, may be mixed into the exposed portion or the entirety of the insulating layer 21 in order to guarantee a sufficient quantity of light in the uncovered regions D1 and D2. Alternatively, a photoemission material layer may be formed on the
20 exposed surface of the insulating layer 21.

FIG. 7 is a plan view of another example of the first plate 2A, illustrating the positional relation between the light emitting layer 20 and the internal electrode 22 formed on the first plate 2A. In this
25 example, the insulating layer 21 is covered with the

light emitting layer 20, and is not exposed to the discharge space 2D. The internal electrode 22 projects from the light emitting layer 20 at one end of the light emitting layer 20 within the uncovered region D1, and simultaneously projects from the light emitting layer 20 along a lengthwise edge thereof in the uncovered region D2. These projecting portions of the internal electrode 22 are exposed to the discharge space 2D. Consequently, the voltage applied between the internal electrode 22 and the external electrode 23 can be maintained low. A photoemission material may be mixed into the electrode material, or a photoemission material layer may be formed on the exposed surface of the internal electrode 22.

FIG. 8 illustrates a plan view of the second plate 2B viewed from the arrow (8) shown in FIG. 3. The uncovered region D1' is located at one end of the light emitting layer 20', and another uncovered region D2' extends from the uncovered region D1' along a lengthwise edge of the light emitting layer 20' in parallel to the longitudinal axis thereof.

FIG. 9 illustrates the positional relation between the light emitting layer 20' and the external electrode 23 formed on the outer surface of the second plate 2B. The external electrode 23 projects

from the light emitting layer 20' formed inside the second plate 2B, and therefore, faces the discharge space 2D via the transparent second plate 2B in the uncovered regions D1' and D2'.

5 In the uncovered regions D1' and D2', the dielectric that forms the second plate 2B is exposed to the discharge space 2D. Because of the photoemission material mixed into the second plate 2B, the light quantity can be prevented from dropping in
10 the uncovered regions D1' and D2'.

 In the uncovered regions D and D' in which the light emitting layer 20 and 20' are not formed, the exposed portions of the plate 2A, 2B, and/or the insulating layer 21 directly face the discharge space
15 2D. These exposed portions contain a photoemission material, such as an oxide of an alkaline-earth metal. The photoemission material may also be mixed into the internal electrode in the uncovered regions D and D'.

 In this manner, at least one of the group
20 consisting of the plate material, the insulating layer 21, and the electrode 22 are exposed directly to the discharge space 2D in the uncovered regions D and D' that are not covered with the light emitting layers 20 and 20' inside the light emitting lamp 2.
25 Consequently, when a voltage is applied between the

electrodes 22 and 23, emission of initial electrons can be facilitated in the uncovered regions, as compared with the other regions covered with the light emitting layer. In addition, because the
5 uncovered regions are formed along the longitudinal axis of the light emitting lamp, the emission of the initial electrons is guaranteed across the entire range of the light emitting layers 20 and 20'. Consequently, the starting characteristic of the
10 light emitting lamp can be improved.

Next, another embodiment of the present invention will be described.

In this embodiment, an additional light source is used to illuminate the uncovered regions that do not
15 include the light emitting layer.

As illustrated in FIG. 1, FIG. 2 and FIG. 4, an external light source 25 (such as an LED, a midget lamp, or an EL) is placed near the light emitting lamp 2. In the preferred example, a blue LED capable
20 of emitting a short-wavelength light with high photon energy is used. The blue LED is arranged so that the light beam is easily guided onto the uncovered regions.

The light emission control of the external light
25 source 25 is performed by a lighting circuit (not

shown), which keeps the external light source 25 in the ON state for a prescribed time prior to activating the light emitting lamp 2.

If the external light source 25 is turned on, the
5 light beam emitted from the external light source 25 irradiates the uncovered regions D and D' of the light emitting lamp 2, which are not covered with the light emitting layers 20 and 20', respectively. In response to the irradiation, initial electrons emit
10 from the photoemission material located at the surface exposed directly to the discharge space 2D. In the electric field produced between the electrodes 22 and 23, the emitted electrons are accelerated and move at a high speed in the discharge gas filling the
15 discharge space 2D, while amplifying the ionization of the discharge gas, and finally reach the light emitting layer or the uncovered region on the opposite electrode side. When ultraviolet rays generated due to the ionization and the excitation of
20 the discharge gas strike the light emitting layer, satisfactory light emission is achieved.

Depending on the polarity of the voltage at the electrode, the electrons and ions generated from the ionization and excitation of the discharge gas are
25 absorbed in the light emitting layer, and the

underlying insulating layer and the electrode. In this case, the electric field between the electrodes may be weakened, and the electric discharge cannot be sufficiently maintained. To prevent this situation, a
5 voltage with an opposite polarity is generally applied between the electrodes to inverse the direction of the electric field in a periodic manner. However, it is generally difficult for those electrons absorbed in the light emitting layer to
10 emit to the discharge space unless the inverted electric field is made strong. Accordingly, it may take a long time for the electron to receive energy sufficient to emit. This means that it takes a long time before electric discharge starts in the
15 discharge gas. In this case, the polarity of the electric field is again inverted to the previous state, without producing light emission during the inverted period.

This undesirable situation can be effectively
20 prevented by the present invention because the uncovered regions D2 and D2' are formed along the longitudinal axis of the light emitting layer 20 and 20'. In the uncovered regions D2 and D2', the electrons can emit promptly from the insulating layer
25 or the electrode at a lower voltage, as compared with

electron emission from the light emitting layer, even if the polarity of the voltage is switched. Thus, light emission can be guaranteed during the discharge period.

5 In general, as the polarity inversion is repeated, the number of electrons emitted into the discharge gas increases, and consequently, the light emission phenomenon occurs in the entirety of the light emitting lamp. However, if the absorption of the
10 electrons in the light emitting layer increases, it generally becomes difficult for the prior art technique to cause the light emitting phenomenon having occurred near the external light source 25 to spread over the entire space of the lamp. In contrast,
15 with the present invention, the uncovered regions D2 and D2' allow electric discharge to easily and promptly spread over the entire space of the lamp, thereby improving the starting characteristic of the light emitting lamp 2.

20 In the above-described example, the uncovered regions D and D' in which the light emitting layers 20 and 20' are not formed are provided at an end opposite to the end portion at which the harnesses 24 and 24' are connected to the electrodes 22 and 23.
25 However, the present invention is not limited to this

example. The uncovered regions D and D' may be arranged at either end. The layout design of the uncovered regions, such as the location or the shape thereof, may be varied depending on the conditions.

5 Although, in the above-described example, the uncovered regions are provided in the light emitting area, the present invention is not limited to this arrangement, and they may be arranged in any part as long as initial electron emission can be carried out
10 reliably. In addition, the photoemission material may be contained only in one of the first and second plates 2A and 2B made of a dielectric material.

In conclusion, photoemission is performed promptly in response to application of voltage
15 between the electrodes of the light emitting lamp, because the light emitting layer is arranged so as to expose a certain region (referred to as an "uncovered region") of the underlying layer to the discharge space. The initial electrons cause electric discharge
20 in the discharge space, where electrically charged particles collide with each other. In the exposed region or the uncovered region, at least one of the first or second plate made of a dielectric material, the insulating layer, and the electrode is exposed to
25 the discharge space. With this arrangement, emission

of the initial electron can start more quickly than in the conventional method. This arrangement can also prevent the ionized electrons, which is generated by irradiation or external faint light, or by electric discharge in the gas filling the discharge space, from being absorbed deep into the light emitting layer. Consequently, photoelectrons can emit to the discharge space easily under application of an inverted electric field at a low voltage. The initial emission of photoelectrons in the low-voltage inverted electric field functions as a "small flame", and it hastens light emission in the other area covered with the light emitting layer. The fabrication cost of the light emitting lamp can be maintained low because of the simple structure, in which a portion of the light emitting layer made of, for example, a fluorescent material, is removed within the area facing the discharge space in which electrically charged particles collide with other particles.

Second, the uncovered region, in which the light emitting layer is not formed, extends from an end of the electric discharge light emitting lamp continuously or discontinuously along the longitudinal axis of the lamp. This arrangement

promotes the electric field to act on the other regions, causing the "small flame" to run and extend to the other regions. If the uncovered region is formed continuously along the longitudinal axis of the electric discharge light emitting lamp, the "small flame" is generated across the length of the light emitting layer, which can hasten the start of light emission from the light emitting layer.

Third, if the uncovered region includes a large-sized region, such a large-sized region is located outside the target scanning area in order to prevent the S/N ratio from degrading during the optical reading. This arrangement is advantageous as compared with the case in which the uncovered region is arranged in the scanning area and light quantity becomes insufficient or uneven.

Fourth, since the photoemission material is contained in the uncovered region, the initial emission of photoelectrons can be performed efficiently, hastening electric discharge in the discharge space.

Fifth, since the uncovered regions face each other across the discharge space inside the lamp body sealed in an airtight manner, emission of photoelectrons from the uncovered region is

guaranteed, avoiding the electron leakage from the area to the light emitting layers. Consequently, the starting characteristic can be improved.

Sixth, by irradiating the uncovered region using
5 an additional light source, emission of photoelectrons from the photoemission material contained in the uncovered region can be promoted, in addition to electric discharge under the application of the electric field. With this arrangement,
10 electric discharge is accelerated by combination of application of the electric field and irradiation from the external light source. Consequently, the starting characteristic can be further improved.

This patent application is based on and claims
15 the benefit of the earlier filing date of Japanese patent application No. 2002-201756 filed July 10, 2002, the entire contents of which are hereby incorporated by reference.